STUDY PROPOSAL

FOR

REPRODUCTIVE SUCCESS AND NESTLING SURVIVAL OF WHITE-FACED IBIS IN RELATION TO HABITAT IN NORTHWEST NEVADA

by

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INTRODUCTION

The white-faced ibis (Plegadis chihi) is a colonial nesting wading bird which is listed under Category 2 of the Endangered Species Act as a species of concern because of its vulnerability to fluctuating climatic and habitat conditions which affect the productivity of the Great Basin breeding population. Several serious drought periods in the 1960s prompted concern which resulted in the current classification (Ryder 1967, Herron et al. 1978). The white-faced ibis management guidelines for the Great Basin population were completed in 1985 because of this concern (Sharp 1985). The resultant management objectives emphasized the maintenance of breeding habitat at the major and persistent colony sites to achieve a minimum of $\geq$ 7,500 breeding pairs in the Great Basin. These colonies include the 1) Carson Lake-Stillwater Complex, Nevada, 2) Malheur NWR, Oregon, and 3) Great Salt Lake, Utah (Figure 1).

White-faced ibis nesting requirements seem to be relatively specific (Ryder 1967) with regard to vegetation structure (Burger and Miller 1977), and stability (Beaver et al. 1980). Deep-marsh emergent vegetation such as hardstem bulrush (Scirpus acutus) and, to a lesser extent, cattail (Typha spp.) seem to be the preferred nesting habitat (Sharp 1985; Hancock et al. 1992). Fluctuations in the numbers of breeding pairs and colony displacement throughout the Great Basin apparently are a direct response to changes in nesting habitat caused by drought (Thompson et al. 1979; Steele 1980), flooding (Ivey et al. 1988; Henny and Herron 1989), and competition for water by an increasing human population (Sharp 1985).

Little information is available which addresses demography parameters of white-face ibis. Ryder (1967) analyzed banding recovery data (from nestlings banded between 1916-1957) and estimated an annual mortality rate of 54% for the first year and 43% thereafter. He concluded that the population would remain stable if ibis breed during their first year and a mean of 1.9 fledglings/breeding pair are annually produced. Research from Smith (1970) indicated that first breeding does not occur until after 2 years-old. In addition, estimations of mean number of fledglings/nest varies: 1.4-1.6 in Utah (Kotter 1970), 1.8-2.6 (per successful nest) in Texas (King et al. 1980), 0-2.4 in Colorado (Schreur 1987), and 1.0-1.6 in Nevada (USFWS 1994).

Measurements of reproductive success are limited because nestlings are mobile after 10 days old. Therefore, nest success is usually given in terms of number of young surviving to a given observable age (Frederick et al. 1993). If mortality is primarily concentrated prior to day 10, the use of an early fledgling age criterion may not lead to significant over estimation of reproductive success. However, if mortality is significant among older chicks, the estimate of success may

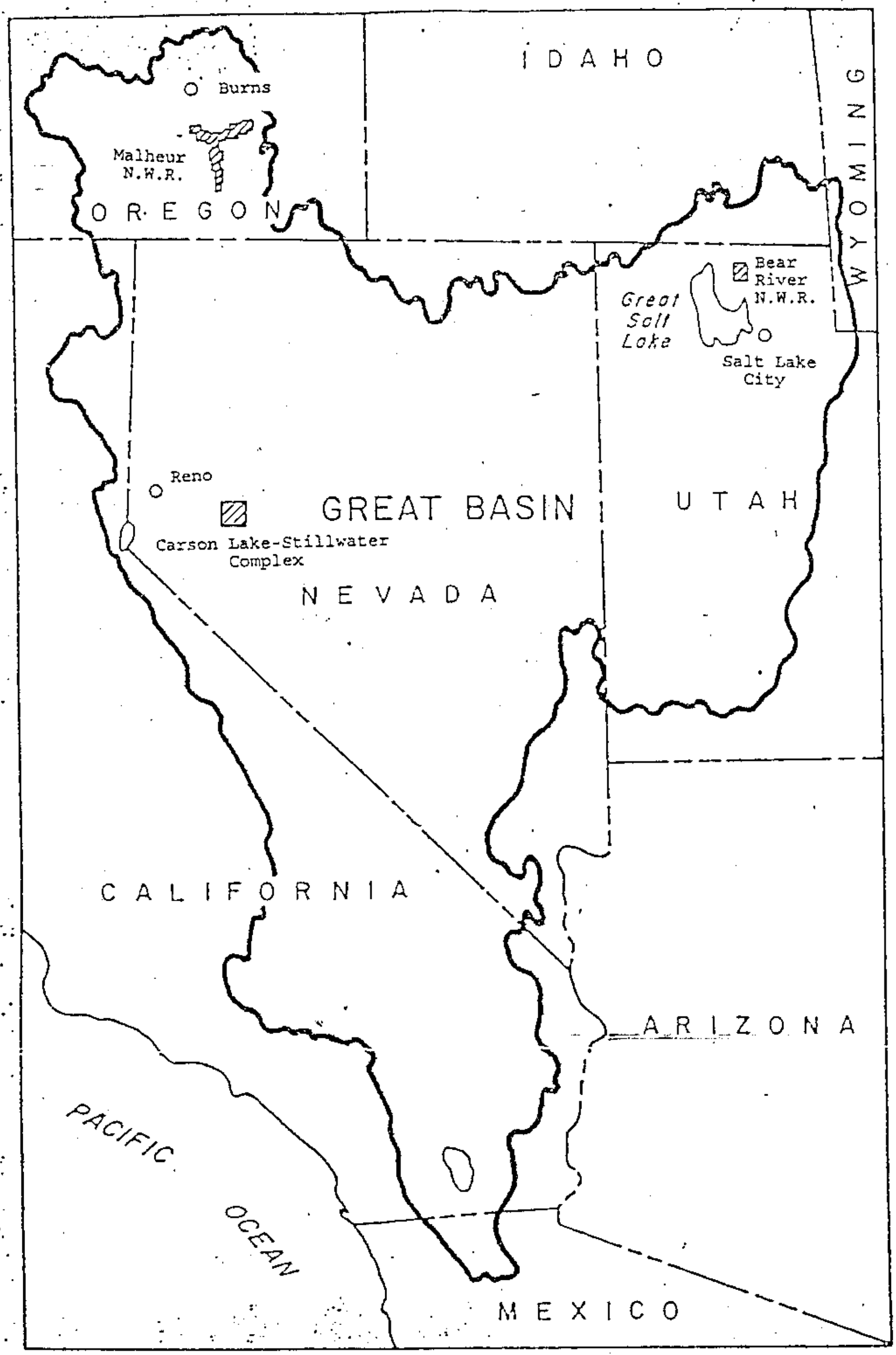

Figure 1: The major and persistent breeding colony sites for white-faced ibis in the Great Basin (modified from Littlefield and Thompson 1981).

substantially differ from the "actual" reproductive success (Erwin and Custer 1982).

Preliminary analysis of the 1994 pilot study data indicated a trend in 3 egg clutches (the mode) in which the late-hatching chicks were found dead (usually in an emaciated condition in the bottom of the nest) but succeeded by its 2 older siblings. However, because of their ambulatory nature, it is unknown whether or not both siblings survived.

The goal of this study is to determine nesting success, survival rate of nestlings, and recruitment of fledglings relative to habitat conditions within major nesting colonies in the Great Basin. This is necessary to develop local water management strategies, with consideration of habitat and population trends, to ensure long-term breeding population viability.

Objectives (1995 Season)

1) Determine juvenile recruitment, survival, habitat selection, and home range in relation to water and habitat availabilities during the breeding season.

2) Quantify nest site characteristics and analyze relative to reproductive success and nest site selection.

3) Determine movements of juveniles and adults during the post fledgling period.

STUDY SITES

In Lahontan Valley, the major colony site has historically occurred at Carson Lake. Since 1985, breeding white-faced ibis have responded to fluctuating habitat conditions by dispersing into suitable alternate sites. These include the Stillwater NWR, Canvasback Gun Club, and Sleeper Wetland (Figure 2).

1) Carson Lake: Located in the lower Carson River drainage basin, in Curchill County, about 90 km east of Reno and 15 km south of Fallon. This wetland varies in size depending on the releases and spills from the Lahontan Reservoir and the Newlands Irrigation Project. Carson Lake is divided into three primary units: Sprig, Rice, and Big Water, of which approximately 2,631 ha of wetland habitat has historically been used by nesting ibis (Figure 3). White-faced ibis have nested in each of the three units depending on the extent of emergent vegetation and water availability at the onset of nesting.

2) Stillwater Point Reservoir: Located within Stillwater NWR, varies in size from 120 to 730 ha of wetland habitat (Figure 4). Over the past three years, spring and summer surges of drainwater from the Newlands Project area has created conditions conductive to the propagation of dense stands of bulrush(*Scirpus acutus* and *S. maritimus*), interspersed with stands of *Typha angustifolia* and *T. latifolia*.

3) Canvasback Gun Club: A privately owned wetland, adjacent to Stillwater NWR, is part of the historic deep-water marsh of the Stillwater wetlands (Figure 4). This area consists of several deep ponds with dense old-growth stands of *S. acutus*.

4) Sleeper Wetland: Located in Desert Valley, adjacent to the Black Rock Desert, in Humboldt County, approximately 45 km northwest of Winnamuca. Sleeper wetland is an ephemeral emergent marsh, approximately 1,620 ha, which was created as a bi-product of de-watering the Sleeper open pit gold mine. This marsh contains dense homogeneous stands of *T. angusifolia*.

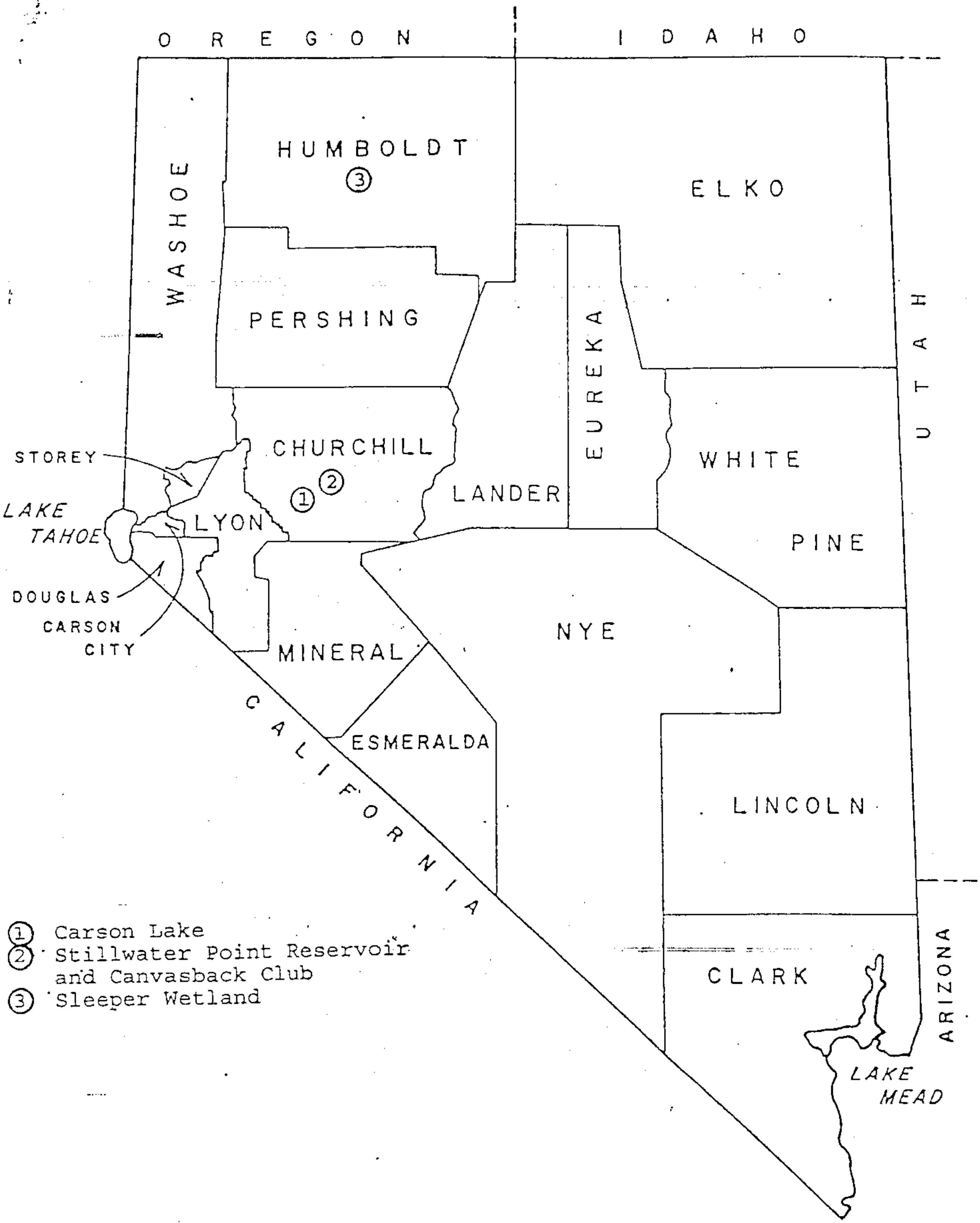

Figure 2: Location of study sites in Northwest Nevada.

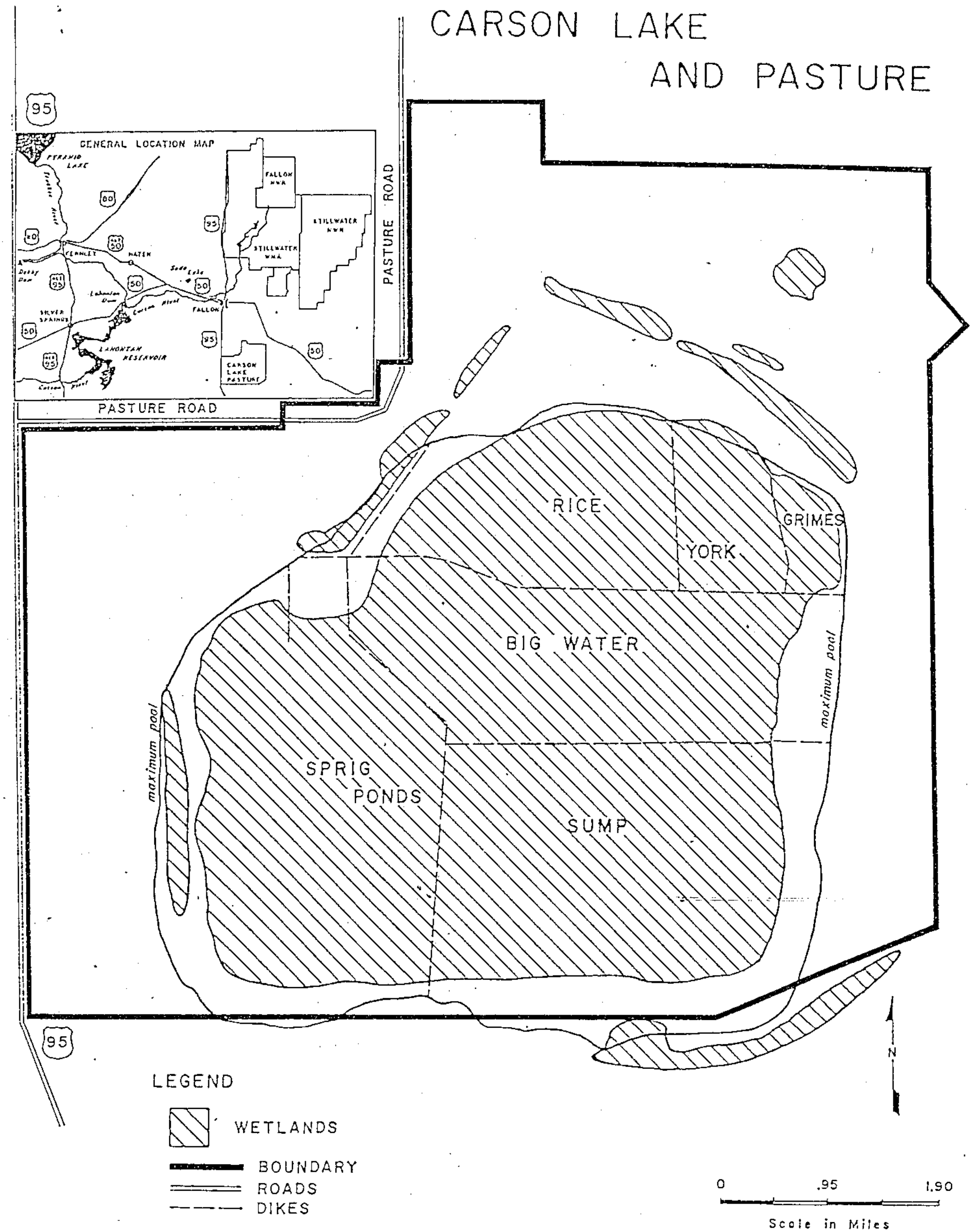

Figure 3: Location of Carson Lake study site.

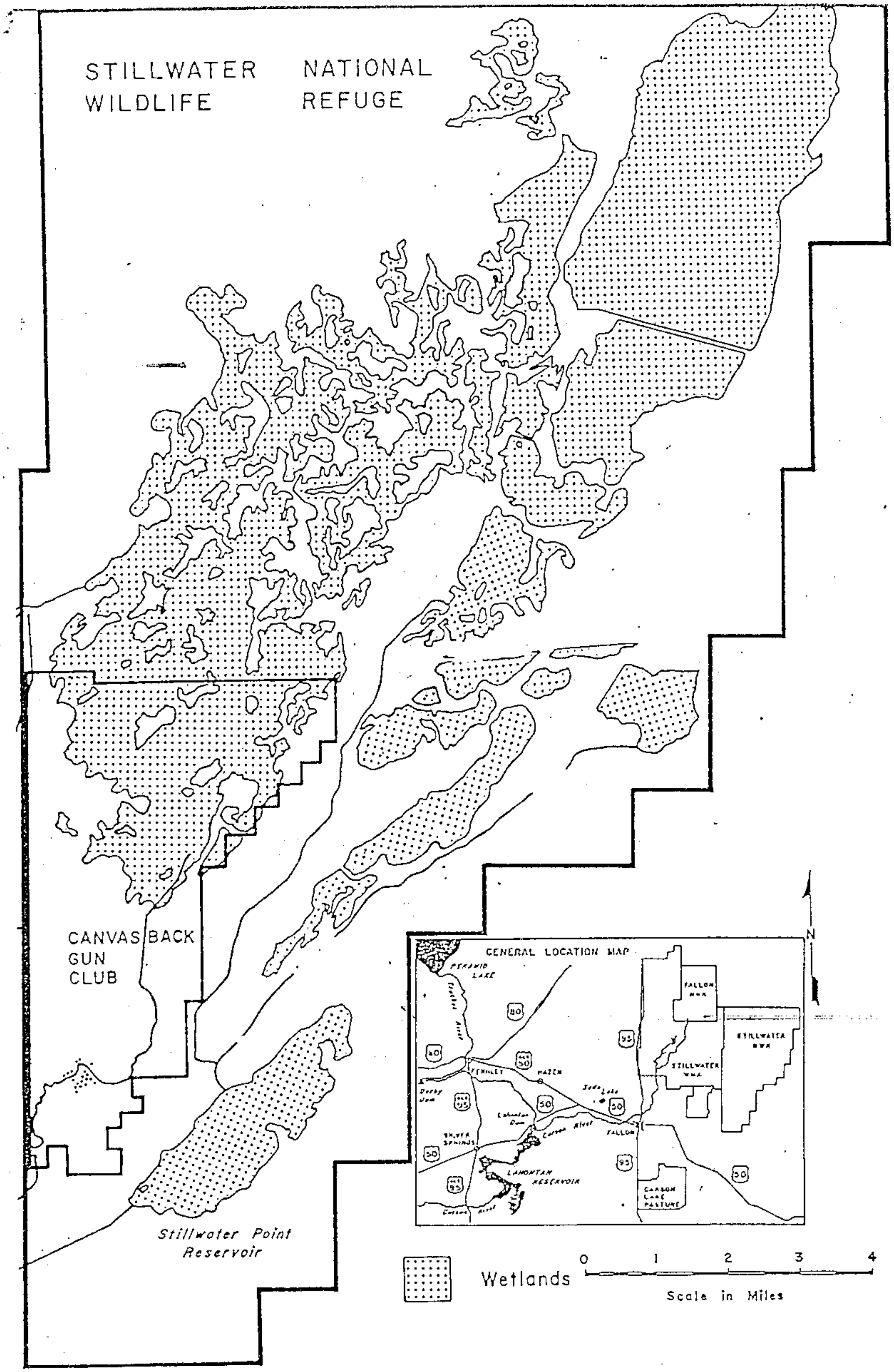

Figure 4: Location of Stillwater Point and Canvasback Club study sites.

METHODS

Aerial Census

Colony locations and estimation of total number of nesting pairs and fledglings will be determined by aerial census using Bell Jet Ranger Helicopter. Two surveys will be conducted, one in mid to late May or early June and one in late June. The first count generally represents total nesting pairs while the second count represents successful pairs. Aerial census are conducted according to methods described in both NDOW Federal Job Progress Reports (1986) and Stillwater NWR files (Annual Narrative Report 1986). To account for aerial sampling error specific to emergent wetland colonies, visibility correction factors obtained from air:ground comparisons at Malheur NWR in southeastern Oregon will be incorporated in pair count calculations (S.P. Thompson, refuge files, Stillwater WMA, Nevada, unpubl. rept.).

Total breeding pairs for each colony will be derived from the initial aerial surveys. Mean number young fledged per nest will be multiplied by the second aerial count to estimate total fledglings produced per colony. The second aerial count is selected because it better reflects successful pairs.

Reproductive Success (Nest Monitoring)

After clutch completion, belt transects (2 meters wide) will be established in 4 colonies with $\geq$100 nesting pairs. Transects will be laid perpendicular to the shoreline from a randomly selected starting point along the shore. This will be duplicated until the sample size of 50 active nests is achieved. The transects will be laid across the width of the colony in order to sample nests on the periphery and within the interior. This is necessary to reduce two possible sources of sampling bias: 1) differential nest success resulting from nest site location within a colony (Coulson 1967), and 2) asynchronous nest chronology. All active nests encountered within the belt transect will be marked with survey flagging (within 1 meter of the nest) and numbered accordingly.

Reproductive success data will be collected from three nest visits to minimize nest disturbance. In addition, the visit duration will be short (1-3 minutes), and performed only during early morning (0500-0830) or evening (0700-0900) hours to avoid heat stress and/or abandonment of the eggs or nestlings. The nest visits are described as follows:

1) First Nest Visit: will be conducted while establishing the belt transect(s), within the first week of incubation. The data collected will include clutch size, float stage (Westerskov 1950) of each egg (laying order and age), and estimated clutch initiation and hatch dates.

2) Second Nest Visit: will be conducted during the hatching stage (15-20 days after first visit) to determine the number of eggs hatched/nest and estimated hatch date.

3) Third Nest Visit (Nestling Fate): will be conducted when the chicks are 8-10 days old (8-10 days after the second visit) to determine the number of chicks surviving/nest.

After chicks are 10-12 days old they become increasingly mobile and are difficult to locate or count accurately (Frederick, et al 1993). This situation is very evident in dense stands of *Scirpus acutus* or *Typha*. Therefore, all chicks reaching the age of 10 days old will be assumed fledged until radio-telemetry data on nestling survival is analyzed.

Reproductive success within each colony will be evaluated by the following parameters: mean clutch size, nesting success, and fledgling success. Nesting success will be estimated using the apparent (traditional) method. This is calculated as the number of successful nests (nests having at least 1 egg hatch) divided by the total number of nests. Fledgling success (an estimate of annual productivity) is calculated as the mean number of nests having at least 1 chick fledge, divided by total number of successful nests.

Nesting success will be compared among colonies using a Chi square contingency table analysis (Zar 1984). The null hypothesis is the proportion of successful and unsuccessful nests are the same among all colonies sampled. The level of significance will be set at 0.05. If reproductive success does not differ among colonies, nests will be pooled to determine nesting and fledgling success of the population.

Nest Site Characteristics

Nest variables (Table 1) will be measured at 25 random nest sites (a sub-sample of the 50 nests) within each of the 4 sampled colonies to characterize and quantify aspects of their breeding habitat which may effect reproductive success.

Water depth, live vegetation height, and residual (dead) vegetation height will calculated as mean of 4 values sampled at the cardinal points 1.0m from the nest rim. Percent cover (for all plant species encountered, residual vegetation, and water) will be a visual estimation within a 0.7m x 0.7m square quadrant, also calculated as above. These measurements will be taken only on the nest fate visit to limit disturbance.

Nest variables measured at the nest sites, except nest height and substrate, will also be measured at 25 random sites using the same sampling design. The random samples will be taken outside of each respective colony boundary within the same marsh and within similar nesting habitat.

A multiple analysis of variance (MANOVA) will be used to test for significant differences among 1) vegetation and water characteristics, relative to successful and unsuccessful nests, 2) vegetation and water characteristics, relative nest sites and random sites. Analyses will be performed using the SPSS package and tested at a 0.05 level of significance.

In addition to the above measured variables, water levels will be monitored once every 5 days from gauges established at each colony. These data will be used to generate mean water surface area measurements per relevant biological period. Each period (n=4) will consist of 30 days (total of 4 periods=120 days). Period means will be calculated from 6 values. The periods are described as follows:

Period 1: Arrival on site, pair-formation, nest building, and clutch initiation.

Period 2: Clutch initiation and completion, incubation, hatching.

Period 3: Hatching to flight capable (HY).

Period 4: Flight capable to independent.

A 2-way ANOVO will be used to test for significant differences between reproductive success (i.e. nesting and fledging success) in each sampled colony relative to mean water surface area in each biological period. Analyses will be performed using the SPSS package and tested at a 0.05 level of significance.

Table 1: List and description of nest site variables.

1) Water Depth (cm): mean of 4 values sampled at the cardinal points 1.0m from nest.

2) Distance to Open Water (m): measured distance from nest to open water.

3) Nest Height (cm): measured from the bottom of the nest bowl to the water surface.

4) Nest Substrate: attached to live, dead, or part-dead vegetation, plant species, and if the nest is or is not resting on residual vegetation.

5) Vegetation Height (cm): mean of 4 values sampled at the cardinal points 1.0m from nest.

6) Height of Residual (cm): dead vegetation which is not standing and forms a layer above the surface of the water. Mean of 4 values sampled at the cardinal points 1.0m from nest.

7) Percent Cover (%): visual estimation of cover within 0.7m x 0.7m square quadrant. Mean of 4 values sampled at the cardinal points 1.0m from nest.
   - a) Residual (dead) Vegetation: standing and laying down.
   - c) Plant Species: % of coverage within each quadrant.
   - d) Open Water: % of coverage within each quadrant.

Nestling Survival Rates

Ten nests will be randomly sampled from 3 colonies and one chick from each nest will be radio-marked during the nest fate visit (n=30 chicks and 30 nests). The sample will be restricted to first (n=15) and second (n=15) hatched chicks from 3 egg clutches. This sample represents fledged individuals as per the early fledge criterion (the number of chicks in the nest at day 10). Depending on nesting synchrony, size of the colony, and survival rate of the original sample, new radio-marked chicks will be added as the study progresses.

Radio-marking will be accomplished by using a two-stage 2.0-3.0 g radio transmitter (PD-2, Holohill Systems Ltd., Ontario, Canada). The weight is less than 4% body weight (200-250 g at 8-10 days old). Transmitters will be attached on 8-10 day old chicks using subcutaneous sutures, affixed on the posterior portion of the back between the wings.

After chicks are radio-marked, they will be located with a receiver (model R4000, ATS, Isanti, MN) and a 3-element yagi antenna once every day until they become flight capable (fledge) Once fledged, they will be monitored three times a week with a truck-mounted, 5-element, null-peak antenna system.

Radio-marked birds will located by triangulations generated from $\geq$3 bearings taken from permanent stations erected on the periphery of each colony during the pre-fledging stage. Each station location will be determined precisely using a GPS unit. After fledging, bearings will be taken from locations determined from a mobile GPS unit.

LOCATE II will be used to generate error (95% confidence ellipse) associated with the triangulations, and estimate locations via the Lenth (1982) maximum likelihood (MLE) algorithm.

If the location of the bird does not change after two telemetry sessions and no movement is detected from changes in signal polarization or modulation, the bird will be located and its status (i.e. mortality) visually confirmed.

Survival rates will be calculated using the Kaplan and Meier estimator, modified for staggered entry (Pollock et al. 1989). Survival rates will be standardized on a 70 day monitoring period. The Wilcoxon Paired-Sample Test (Zar 1984) will be used to test for differences between survival rates among the first and second chicks. Determination of hatching sequence will be through chick measurements taken at the time of radio-marking, the first chick being larger. The log rank-rank test (as described by Pollock et al. 1989) will be used to compare survival function between colonies. The level of significance will be set at 0.05.

Habitat Selection and Home Range

Habitat selection and home range data will be collected during the 1995 season. Data will be analyzed pending logistical constraints. Radio-marked bird locations will be determined as above.

Habitat Selection

The monitoring period will be divided into pre-fledged (35 days) and fledged (35 days) segments, representing specific activity patterns. Use versus habitat availability within the birds home range (third-order habitat selection) will be analyzed using the Marcum and Loftsgaarden (1980) method because availabilities for wetland habitats will likely change throughout radio tracking period. Habitat availability will be estimated using random locations sample from aerial photos.

The following habitat types will be recorded during each telemetry session:

1) Marsh:
   - a) Open Water Marsh: bird located on shoreline of reservoir, pond, etc..
   - c) Emergent Vegetation Marsh: bird located in homogeneous or heterogeneous emergent vegetation.

2) Irrigation Canal

3) Agricultural Field: note whether flooded or not.
   - a) Alfalfa Field
   - b) Fallow Field
   - c) Pasture Field
   - d) Other Field: oats, corn, barley, old field

Home Range

Home range will be estimated using the bivariate normal (Calhoun and Casby 1958) method. Analysis will be conducted using the CALHOME home range analysis program (MS-DOS Version 1.0). Goodness-of-fit tests proposed by Smith (1983) and Samuel and Garton (1980) will be used to validate the underlying assumption of independence. To reduce the influence of excursions (i.e. extreme locations in the data set) the method proposed by Samuel and Garton (1985) and Koeppl and Hoffmann (1985) will be employed.

Banding and Color Marking

Capture Techniques

Three techniques will be used to capture white-faced ibis:

1) Hand Capture: Locate, band, and color mark nestlings in their natal colony just prior their flight capable stage (21-28 days old). A group of biologists (banders) and volunteers (runners) are needed. To limit disturbance, this technique will only be used on the last pre-fledgling group of birds in each colony.

2) Mist Netting: Capture fledglings using canopy mist-nets (121mm) placed within a creche at their natal colony. Fledglings are lured into the nest using 2-dimensional decoys which are placed on both sides of the net in a natural gregarious arrangement. This technique will be applied as soon as the creche stage begins. Creche formation occurs after nestlings are approximately 28 days old (Kotter 1970).

3) Rocket Netting: Capture adults and fledglings outside of their natal colony. Decoys will be placed in flooded agricultural fields to attract ibis to the capture site. This technique will be applied halfway through the breeding season while the eggs are still being incubated. This will continue until all birds leave the study area.

Banding and Color Marking

Color marking will be accomplished by using leg streamers constructed from Herculite "80" (vinyl/nylon fabric), a technique developed by Frentress (1975) and modified by Telfair (1983). This technique has been selected because of its durability (Nesbitt 1979), little color fading (Telfair 1993) and ease of attachment. The leg streamer (6.8 X 2.3 cm) will be attached onto each bird by inserting a U.S. Fish and Wildlife Service metal band through a double layered "pop" riveted loop and closed onto the tibia-fibula (i.e. above the intertarsal joint or "ankle") (Figure 5).

The following leg streamer colors will be used throughout the study: Red, Blue, White, and Yellow. NAZ-DAR vinyl-based ink colors (Black, White, Yellow, and Red) will be applied to the leg streamers to increase color combinations. The leg streamer will consist of two colors, the original Herculite color and 1 dyed color. To facilitate identification of the individual, each streamer will also receive a unique alpha-numeric combination. Only one leg streamer will be used per bird, either on the left or right leg.

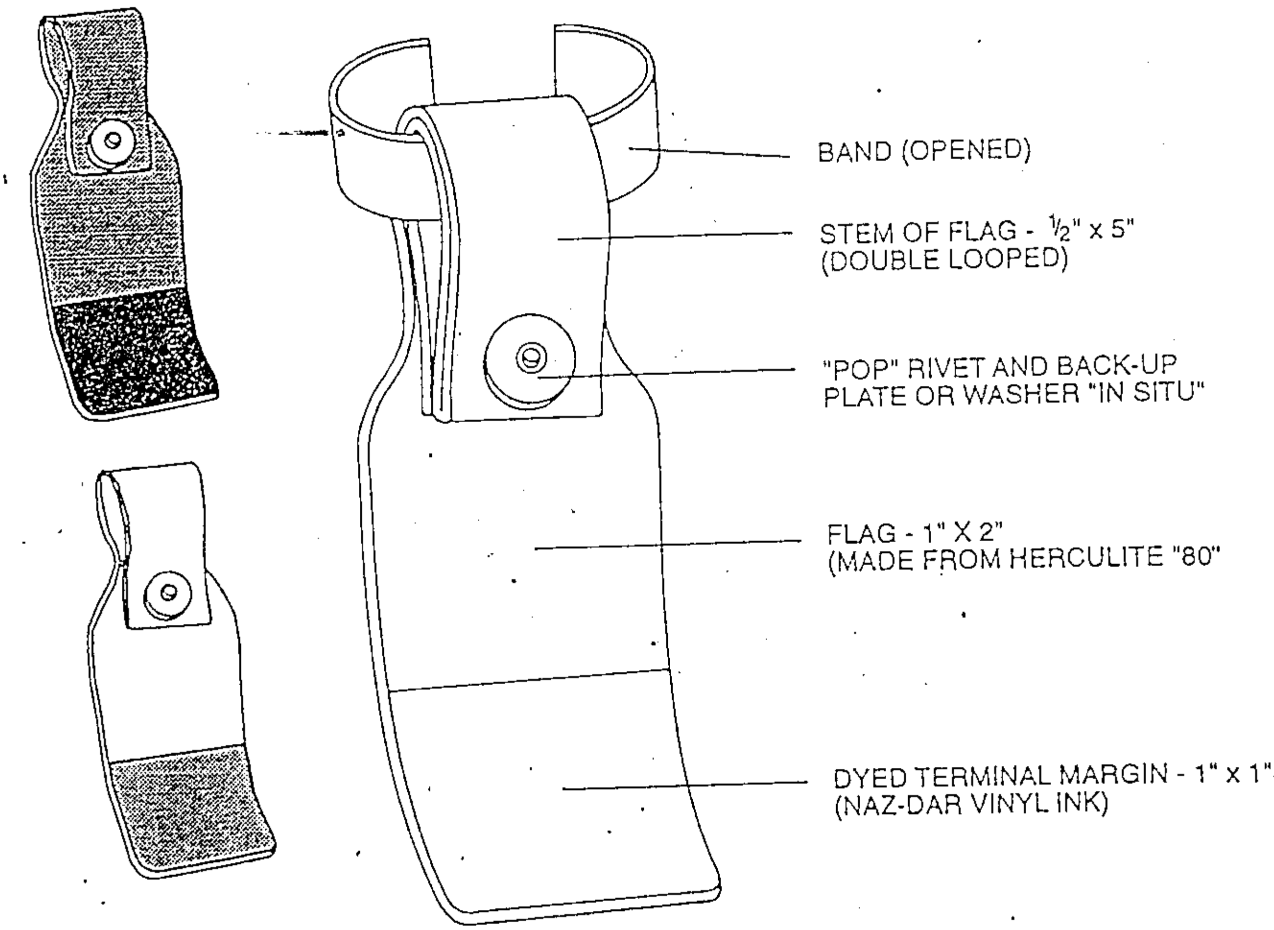

Figure 5: Diagram and completed examples of Herculite "80" leg streamers (from Telfair 1993).

Juveniles (age class 0-1 year) and adults (age class 3+) will be separated and individually marked. These two cohorts will represent Lahonton Valley as a single colony. Ibis captured outside of this area will be differentiated. This marking technique will facilitate data collection on 1) the breeding dispersal of adults, and local movements of fledglings, within the study area, and 2) the post-breeding dispersal of adults and juveniles throughout the Great Basin.

Resighting Color Marked Ibis

Resighting color marked ibis will be done throughout the Stillwater NWR and Carson Lake study area using vehicular surveys. Data will be collected daily (n=2-4hrs/day) on adults and juveniles starting after the first capture session and after fledging, respectively. The following data will be recorded in the field for each resighted bird:

1) Date, time, color combination and alpha-numeric code
2) Habitat type: same as in habitat selection section
3) Behavior: foraging, roosting, loafing, and nesting
4) Group size and ratio of marked to unmarked birds

The capture-resight data will be analyzed using the program JOLLYAGE to obtain estimations of survival rates and population size of both juveniles and adults (Pollock et al 1990).

In addition, National Wildlife Refuges and nonprofit organizations (Audubon Society, Nature Conservatory, etc..) throughout the Great Basin will be notified about the color marked ibis. Data on dispersing adults and juveniles will be dependent upon the amount of assistance the study receives.

Cooperators

Participating agencies include Nevada Division of Wildlife (NDOW) and U.S. Fish and Wildlife Service personnel at Stillwater NWR.

Responsibility

Accountable U.S. Fish and Wildlife Service personnel at Stillwater NWR are as follows:

1) Bill Henry: (supervisor) reviews all written reports and assists with field work if necessary.
2) Anita DeLong: (project leader) assists with logistics, research design, and reviews written reports.
3) Eric Kelchlin: involved in all aspects of study, in addition to writing the research proposals, annual reports, and final report.

Accountable Nevada Division of Wildlife personnel are as follows:

1) Larry Neel: (Nongame Wildlife Biologist) aerial census of Northwestern Nevada colonies and summarizes the corresponding flight data.

Field Schedule

The study will be initiated on March 20, 1995. Purchasing equipment and constructing color bands will be done between March 20 and May 10. The field season will begin after May 10 and last until September 15 (approximately) (Figure 6).

Reports

Annual progress reports will be submitted on the 15th of every month from April through September, 1995. The draft final report will be due on November 15 and a revised final report will be due on December 15, 1995. The finished final report will be due on December 31, 1995. The final report will represent a M.S. thesis and section(s) of or all of the study will be published thereafter.

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1995 Study Budget

Region 1 Nongame Budget Contribution

Stillwater NWR Field Work:

Wildlife Technician....................................$9750.00
Field Equipment:
  a) Radio-transmitters ($160.00 x 30).................$4800.00
  b) Color Marking......................................$155.00
  c) Rocket Net Charges.................................$200.00
  d) Receiver Equipment and Maintenance.................$250.00
  e) Fuel and Repair to Airboat & Vehicles..............$400.00

REGION 1 NONGAME TOTAL.................................$16,755.00

Stillwater NWR Budget Contribution

Volunteer Housing ($300/month x 3)......................$900.00
Airboat, Vehicles, Fuel.................................$300.00

Field Equipment:
  a) Rocket Net Charges.................................$200.00
  b) Receiver equipment and maintenance... ....$250.00

STILLWATER NWR TOTAL...................................$1,650.00

Nevada Division of Wildlife Budget Contribution

Helicopter Aerial Surveys..............................$2300.00
Rockets (for Rocket-net)................................$200.00
Rocket Net Charges......................................$400.00

NDOW TOTAL...$2900.00

1995 STUDY TOTAL.......................................$21,305.00

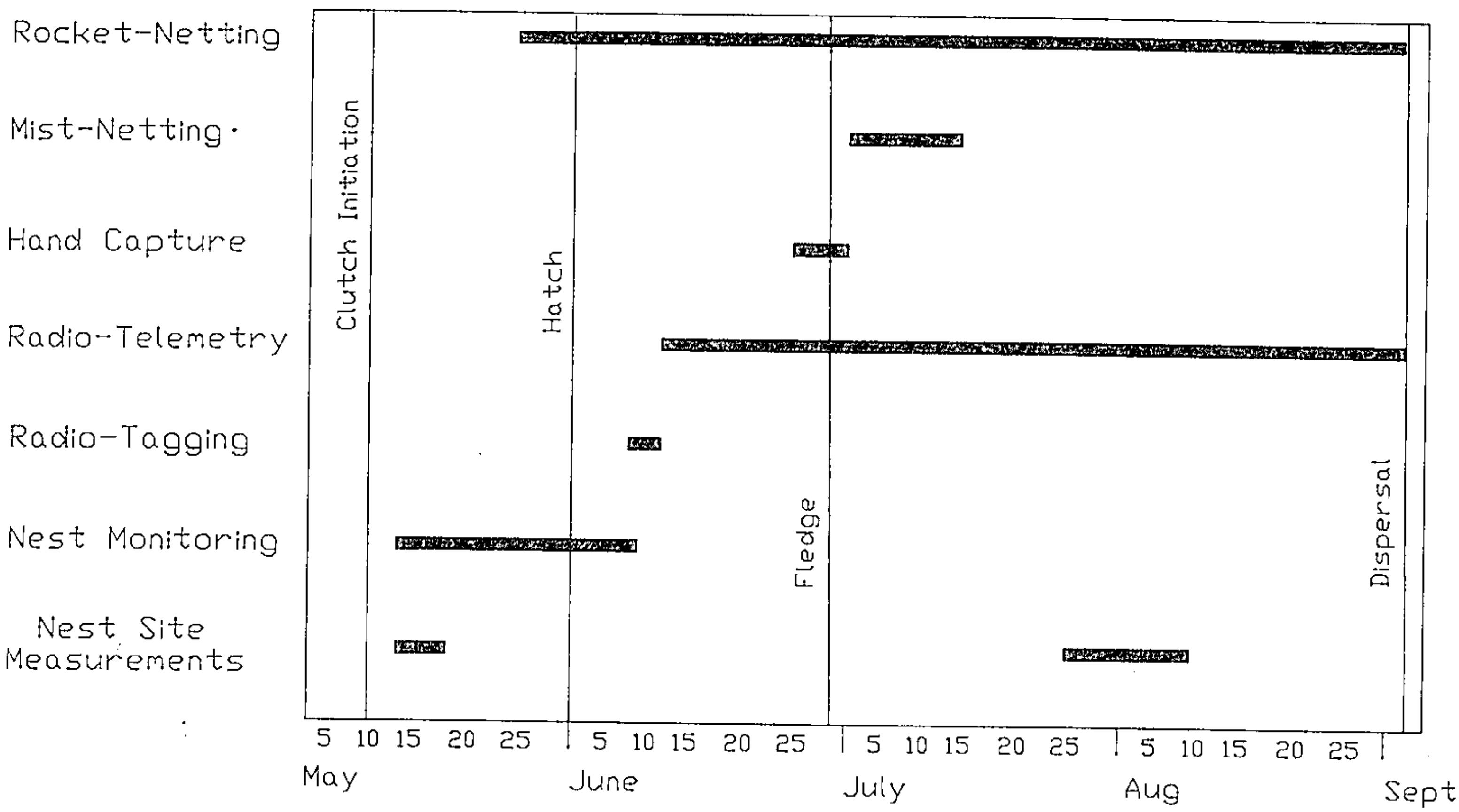

Figure 6: Schedule of field techniques, 1995 season.